
Name of Organization: NOAA/GLERL

Type of Organization: Federal Agency

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Project Title: Tumor-Like Anomalies in Lake Michigan Zooplankton

Project Category: Emerging Issues

Rank by Organization (if applicable): 0

Total Funding Requested (\$): 64,500 **Project Duration:** 1.5 Years

Abstract:

Tumor-like anomalies (TLAs) have been identified as a serious emerging threat to the well being to the food web in Lake Michigan and other Great Lakes owing to the high frequency of large TLAs found on zooplankton. At certain times these lesions can affect 50-70% of the copepods of certain species in Lake Michigan. Calanoid copepods appear to be especially vulnerable to infestation. The occurrence of lesions was highly variable temporally and spatially in Lake Michigan. TLAs with similar gross appearances in a small lake in Michigan, in Lago Maggiore in Italy and other lakes in Europe and Asia and in brackish waters of Europe, including the Baltic and Black Seas. The first appearance of TLAs in recent years or their recent increase in these systems may indicate the emergence of a global phenomenon with a common cause. Our efforts will focus on describing the histology, etiology, and spatial and temporal distribution so as to characterize the phenomenon and relate it to possible environmental causes in Lake Michigan. Observations of behavior and survival will give us insights into the consequences of the TLAs to the zooplankton. We will also obtain samples of zooplankton TLAs from our collaborators abroad to evaluate whether TLAs in their systems are the same as ours. Comparisons with ongoing studies in Europe will give added power to our results.

Geographic Areas Affected by the Project

States:

- | | |
|--|---|
| <input checked="" type="checkbox"/> Illinois | <input type="checkbox"/> New York |
| <input checked="" type="checkbox"/> Indiana | <input type="checkbox"/> Pennsylvania |
| <input checked="" type="checkbox"/> Michigan | <input checked="" type="checkbox"/> Wisconsin |
| <input type="checkbox"/> Minnesota | <input type="checkbox"/> Ohio |

Lakes:

- | | |
|--|---|
| <input type="checkbox"/> Superior | <input type="checkbox"/> Erie |
| <input type="checkbox"/> Huron | <input type="checkbox"/> Ontario |
| <input checked="" type="checkbox"/> Michigan | <input checked="" type="checkbox"/> All Lakes |

Geographic Initiatives:

- | | | | | |
|--|----------------------------------|-------------------------------------|--------------------------------------|---|
| <input type="checkbox"/> Greater Chicago | <input type="checkbox"/> NE Ohio | <input type="checkbox"/> NW Indiana | <input type="checkbox"/> SE Michigan | <input type="checkbox"/> Lake St. Clair |
|--|----------------------------------|-------------------------------------|--------------------------------------|---|

Primary Affected Area of Concern: Not Applicable

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area:

Other Affected Biodiversity Investment Areas:

Problem Statement:

Tumor-like anomalies (TLAs) have been identified as a serious emerging threat to the food web in Lake Michigan and other Great Lakes owing to the high frequency of large TLAs found on zooplankton by GLERL, EPA, and University of Michigan. At a recent workshop on the phenomenon at GLERL, the present state of knowledge of the lesions was reviewed and an agenda for research was developed. At times, TLAs can affect 50-70% of the copepods of certain species. Calanoid copepods appear to be especially vulnerable to infestation. The occurrence of lesions was highly variable temporally and spatially in Lake Michigan.

Gretchen Messick of the Cooperative Oxford Laboratory of NOAA's Center for Coastal Environmental Health and Biomolecular Research and John C. Harshbarger of the Registry of Tumors in Lower Animals at George Washington University so far have described 5 kinds of TLAs based on gross appearance and 3 histologic manifestations. The histologic exams showed that the TLAs were not neoplastic, i.e., not cancerous. Histologic studies so far indicate that most TLAs are comprised of either acellular tissue or cells that resemble host cells that have originated from within the animal; some TLAs contain unidentified round bodies of varying sizes which are present both within the copepod and the attached TLA (Figure 1). Due to the numerous gross TLA types encountered so far and the intricate and diverse nature of histologic TLA manifestations, no causative agent has been identified. Further investigation is necessary to determine the etiology for these varied types and whether these different types of TLAs are related. There is indication that some TLAs may be a reactive response to unknown irritant(s). Additional investigations using light and electron microscopy are needed to define the etiology agent(s), distribution of TLAs on the host's body and whether the TLA location on the host is linked to different TLA types. Additionally, investigations are needed to identify what host species are affected, the prevalence among host life stages, and the geographic and time distribution of TLAs among various host species affected. Once this work clarifies the nature of the TLAs, further work will be needed to reproduce the TLAs in the lab to confirm the identity of the etiologic agent.

Workshop participants concluded that histologic definition of the anomalies is the first step to understanding their etiology. Hundreds of animals of various life stages need to be examined histologically to characterize the TLAs. Workshop participants also agreed that temporal and spatial sampling of TLAs should be intensified in Lake Michigan to better define TLA etiology and identify hotspots that would give insight into possible causes through linkage with known or assumed spatial patterns of water quality.

Although several morphologic variations of tumor-like abnormalities (TLAs) have been observed, collaborators have found TLAs with similar gross appearances in a small lake near Ann Arbor, in Lago Maggiore in Italy (Maria Manca), lakes in Europe, Asia; and in brackish waters of Europe, including the Baltic and Black Seas. The first appearance of TLAs in recent years or their recent increase in these systems may indicate the emergence of a global phenomenon with a common etiology.

Proposed Work Outcome:

EPA and GLERL workshop participants recommended expanding their "monitoring" efforts to improve spatial and temporal time series in Lake Michigan in FY 2000 to ensure capturing the development of this spotty phenomenon and getting insights into possible consequences to zooplankton populations.

Ecology: GLERL proposes to build upon the pre-plume (February), plume (March), and post plume survey cruises (April) at all transects and the monthly monitoring at St. Joseph, Muskegon, and Deepwater Station (DWS) by adding monthly cruises at M110 separated by two weeks from the monthly monitoring cruises (Fig. 2). EPA GLNPO will do 4 instead of 2 survey cruises of the offshore stations in Lake Michigan (Fig 3). This intense set of data covering the whole of Lake Michigan will be an important complement to GLERL seasonal data collected for 15 years near M110. Marina Manca, who has been monitoring TLA's from Lago Maggiore in Italy since 1994, will continue her work in concert with ours to determine if there are common global patterns.

Histology and Behavior: We propose to use R/V Lake Guardian in offshore surveys since it's lab facilities allow quick sorting and fixation of fresh animals for histologic examinations. Before fixation, appearance and behavior of live animals with TLAs will be documented. Additionally, live specimens with TLAs will be set aside for more sophisticated behavior and survival studies later in the laboratory to evaluate the effect of the TLAs on affected zooplankton. Gretchen Messick will direct histologic processing and examination at the Cooperative Oxford Laboratory. Various steps leading up to histologic characterization include collecting and sorting zooplankton both with and without TLAs, placing them quickly into appropriate fixatives, embedding specimens in paraffin, sectioning, staining, and finally microscopic examination of tissues. We also propose to histologically compare specimens from collaborators to determine if TLAs from Europe have similar histologic types to those collected in Michigan. Electron microscopy, if necessary, will be carried out at George Washington University.

| Project Milestones: | Dates: |
|---------------------------------------|---------------|
| Project Start--field work | 02/2000 |
| Hire and train histology technician | 06/2000 |
| Hire and train zooplankton technician | 06/2000 |
| Start processing samples | 06/2000 |
| | / |
| | / |
| | / |
| Project End | 06/2001 |

Project Addresses Environmental Justice

If So, Description of How:

Project Addresses Education/Outreach

If So, Description of How:

There has been great interest in the popular media and scientific community about tumor-like anomalies and their possible causes. International conference organizers are already inviting me to give presentations on the phenomenon. Peer-reviewed publications and conference presentations will be used to disseminate results.

Project Budget:

| | Federal Share Requested (\$) | Applicant's Share (\$) |
|----------------------------|-------------------------------------|-------------------------------|
| Personnel: | 37,500 | 48,770 |
| Fringe: | 10,500 | 13,968 |
| Travel: | 0 | 3,700 |
| Equipment: | 0 | 10,000 |
| Supplies: | 2,000 | 5,000 |
| Contracts: | 0 | 0 |
| Construction: | 0 | 0 |
| Other: | 0 | 54,000 |
| Total Direct Costs: | 50,000 | 135,438 |
| Indirect Costs: | 14,500 | 7,900 |
| Total: | 64,500 | 143,338 |
| Projected Income: | 0 | 0 |

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Description of Collaboration/Community Based Support:

Proposed work will be a cooperative effort involving GLERL, EPA GLNPO, and CCEHBR, who will be providing expertise, facilities, and ship support. Major contributions and costs are outlined below. CCEHBR has a long history of excellence in the pathology of crustacean and molluscan diseases. Both GLERL and EPA have complimentary monitoring programs that will be leveraged by the proposed study. Henry Vanderploeg has a long record of research on zooplankton life history and behavior. Gretchen Messick, supported by CCEHBR base funds (50% FTE for a total cost including fringe of \$32,770), is requesting funds for a 50% FTE histology technician (total cost, including fringe = \$17,300) to help process the many zooplankton TLA samples. Vanderploeg is requesting a zooplankton technician (1 FTE = \$34,600) to deal with the increased sample load to count and sort zooplankton, enumerate and describe tumors, and conduct behavioral and survival experiments. GLERL is providing salary for Vanderploeg at 5% FTE and for 2 highly trained support scientists with expertise in zooplankton ecology at 10% FTE each. Vanderploeg is requesting salary support at 5% FTE. GLERL is scheduling 27 days of extra ship time (cost = \$54,000). Vanderploeg's NOAA/NSF funds will provide 20 days on the R/V Lake Guardian and 24 days on the R/V Laurentian to collect zooplankton samples for TLA analysis. EPA is scheduling 2 extra survey cruises on the Lake Guardian in Lake Michigan with its zooplankton counting contractors to sort zooplankton with tumors. GLERL is providing \$5,000 for supplies and the purchase an extra binocular microscope (\$10,000) for the zooplankton technician.